

Comparison of Postoperative Nausea and Vomiting after Propofol-Based Versus Inhalational Anesthesia

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Abstract

Background: Postoperative nausea and vomiting (PONV) are a common complication of general anesthesia and can adversely affect patient comfort, recovery, and discharge. The choice of anesthetic maintenance technique may influence the risk of PONV. Propofol-based total intravenous anesthesia (TIVA) has been associated with lower emetogenic potential compared with volatile inhalational agents. This study compared the incidence of PONV following propofol-based TIVA and inhalational anesthesia.

Methods: Patients were allocated into two equal groups: Group P received propofol-based TIVA (n=40), while Group I received inhalational anesthesia (n=40). Baseline demographic and perioperative characteristics were recorded. PONV was assessed during the 0–2-hour, 2–6-hour, and 6–24-hour postoperative intervals. The primary outcome was the incidence of PONV within 24 hours. Secondary outcomes included postoperative nausea, vomiting, rescue antiemetic requirement, complete response, postoperative pain, opioid consumption, PACU discharge readiness, and adverse events.

Results: Baseline characteristics were comparable between the two groups. The overall incidence of PONV within 24 hours was significantly lower in the propofol-based TIVA group compared with the inhalational anesthesia group (20.0% vs 42.5%, $P=0.030$). Postoperative nausea occurred in 17.5% versus 37.5% of patients ($P=0.045$), while vomiting occurred in 7.5% versus 25.0% ($P=0.034$), respectively.

Conclusion: Propofol-based total intravenous anesthesia was associated with a significantly lower incidence of postoperative nausea and vomiting than inhalational anesthesia.

Keywords: Postoperative Nausea And Vomiting; Propofol; Total Intravenous Anesthesia; Inhalational Anesthesia; Sevoflurane; Antiemetic Prophylaxis; Postoperative Recovery.

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Introduction

Postoperative nausea and vomiting (PONV) remains one of the most frequent and distressing adverse events following general anesthesia. Although improvements in anesthetic drugs, perioperative monitoring, and antiemetic prophylaxis have reduced its occurrence, PONV continues to affect approximately 30% of the general surgical population, while its incidence may approach 80% in patients with multiple risk factors [1,2]. Apart from causing considerable discomfort, PONV may interfere with early oral intake, mobilization, and overall postoperative recovery. Persistent vomiting can contribute to dehydration, electrolyte imbalance, wound stress, bleeding, aspiration, and delayed discharge from the post-anesthesia care unit. In ambulatory surgery, these consequences are particularly important because nausea and vomiting may prolong recovery or lead to unexpected hospital admission [1,2].

The development of PONV is multifactorial and involves interactions among patient characteristics, surgical factors, anesthetic technique, and postoperative medication use. Established patient-related predictors include female sex, a history of PONV or motion sickness, and nonsmoking status, whereas perioperative opioid exposure further increases the risk [3]. The simplified Apfel risk score incorporates four major predictors—female sex, nonsmoking status, previous PONV or motion sickness, and anticipated postoperative opioid use—and remains widely used for estimating an adult patient's PONV risk [3]. The anesthetic technique itself also has an important influence on baseline risk, making the choice between intravenous and inhalational maintenance clinically relevant. Volatile anesthetic agents such as sevoflurane, desflurane, and isoflurane have long been used for maintenance of general anesthesia because they allow rapid adjustment of

anesthetic depth and relatively predictable emergence. However, exposure to volatile anesthetics is an independent anesthetic-related risk factor for PONV, particularly during the early postoperative period. In a large randomized factorial trial, Apfel et al. found that volatile anesthetics were a major contributor to early postoperative vomiting and demonstrated a dose-dependent relationship between volatile anesthetic exposure and emetic events [4]. Consequently, reduction or avoidance of volatile anesthetic exposure has become an important component of strategies aimed at decreasing the baseline risk of PONV.

Propofol-based total intravenous anesthesia (TIVA) provides an alternative technique in which anesthesia is induced and maintained predominantly with intravenous propofol rather than inhaled anesthetic agents. Propofol is attractive in patients susceptible to PONV because it possesses clinically relevant antiemetic properties in addition to its hypnotic effects. A quantitative systematic review of randomized studies demonstrated that maintenance of anesthesia with propofol was associated with a greater reduction in early postoperative nausea and vomiting than its use solely as an induction agent [5]. Thus, the potential benefit of propofol appears to be related not simply to receiving an intravenous induction dose but to avoiding prolonged exposure to emetogenic volatile anesthetics during maintenance of anesthesia.

Evidence directly comparing propofol-based TIVA with inhalational techniques has generally favored propofol for early PONV prevention, although the size of the benefit varies with surgical population, baseline risk, use of nitrous oxide, perioperative opioids, and antiemetic prophylaxis. In a systematic review and meta-analysis involving 18 randomized trials and 1,621 ambulatory surgical patients, Kumar et al. reported PONV in 13.8% of patients receiving propofol compared with 29.2% of those receiving sevoflurane or desflurane [6]. However, the advantage did not clearly extend to post-discharge nausea and vomiting, showing that the effect of anesthetic technique may vary according to the postoperative time period [6]. An important consideration is whether propofol-based anesthesia remains superior when patients receiving inhalational anesthesia are also given effective antiemetic prophylaxis. Schaefer et al. compared propofol-based TIVA with inhalational anesthesia combined with a single prophylactic antiemetic and found no significant difference in the overall risk of PONV between these approaches [7]. Modern PONV prevention therefore increasingly follows a multimodal strategy rather than relying on a single intervention. Large network meta-analysis data have confirmed the effectiveness of several

pharmacological classes, including 5-hydroxytryptamine-3 receptor antagonists, corticosteroids, neurokinin-1 receptor antagonists, and dopamine antagonists [8]. Current consensus guidance similarly recommends combining baseline-risk reduction with appropriately selected antiemetic prophylaxis according to the individual's risk profile [1].

Nevertheless, anesthetic choice remains clinically important because avoidance of volatile agents represents a nonpharmacological method of reducing baseline emetic risk without adding another antiemetic medication. Contemporary evidence continues to support this concept. A 2026 systematic review and meta-analysis of randomized studies comparing propofol-based TIVA with sevoflurane in ambulatory surgery found that TIVA was associated with a lower risk of PONV, with a pooled risk ratio of 0.67, although recovery-time outcomes were less consistent [9].

These findings indicate that the principal advantage of propofol-based anesthesia may lie in improving postoperative symptom control rather than producing universally faster emergence or discharge.

Despite extensive research, differences in surgical procedures, patient risk profiles, perioperative opioid exposure, prophylactic antiemetic regimens, and definitions of PONV make direct comparison between anesthetic techniques challenging. Furthermore, the increasing emphasis on enhanced recovery and patient-centered outcomes makes prevention of postoperative nausea and vomiting an important measure of anesthetic quality.

A direct comparison of PONV following propofol-based and inhalational anesthesia can therefore provide clinically meaningful information regarding the contribution of anesthetic maintenance technique to postoperative recovery. The present study aims to compare the occurrence of postoperative nausea and vomiting after propofol-based anesthesia versus inhalational anesthesia and thereby assess whether the choice of anesthetic technique is associated with a meaningful reduction in postoperative emetic symptoms.

Materials and Methods

This prospective, randomized, assessor-blinded, parallel-group comparative study was conducted in the Department of Anaesthesiology at Rural Medical College, Loni, during the period from January 2022 to March 2022. The study was designed to compare the incidence and severity of postoperative nausea and vomiting (PONV) following propofol-based total intravenous anesthesia (TIVA) with those following inhalational anesthesia in adult patients undergoing

elective surgical procedures under general anesthesia.

Study Population: A total of 80 adult patients scheduled to undergo elective surgery under general anesthesia were enrolled in the study. Participants were allocated in a 1:1 ratio to either the propofol-based TIVA group or the inhalational anesthesia group, resulting in 40 patients in each group.

Eligibility Criteria: Patients aged 18–65 years, of either sex, with an American Society of Anesthesiologists (ASA) physical status classification of I or II and scheduled for elective surgery requiring general anesthesia with endotracheal intubation were considered eligible. Only patients expected to undergo surgical procedures of sufficient duration to permit maintenance of anesthesia with the assigned technique were included.

Patients were excluded if they had pre-existing nausea or vomiting within 24 hours before surgery, known hypersensitivity or contraindication to any study medication, pregnancy or lactation, significant hepatic or renal dysfunction, neurological or gastrointestinal disorders associated with nausea and vomiting, chronic opioid use, regular use of antiemetic medication, alcohol or substance dependence, or inability to provide informed consent. Patients requiring conversion to an anesthetic technique substantially different from the allocated protocol were documented separately and included in the intention-to-treat analysis where appropriate.

Preoperative Assessment: All patients underwent a standardized pre-anesthetic evaluation, including documentation of demographic characteristics, body mass index, ASA physical status, relevant comorbidities, previous history of PONV or motion sickness, smoking status, current medication use, and previous anesthetic exposure.

The baseline risk of PONV was evaluated using the simplified Apfel risk score, based on four established risk factors: female sex, nonsmoking status, previous PONV or motion sickness, and anticipated postoperative opioid administration. Preoperative fasting and routine medication instructions were standardized according to institutional practice.

Randomization and Allocation Concealment

Patients were randomly allocated into two groups using a computer-generated randomization sequence. Allocation was concealed using sequentially numbered, opaque, sealed envelopes that were opened immediately before induction of anesthesia by an anesthesiologist not involved in postoperative outcome assessment.

The two study groups were defined as follows:

Group P: Propofol-based TIVA (n = 40): General anesthesia was maintained predominantly using an intravenous propofol infusion.

Group I: Inhalational anesthesia (n = 40): General anesthesia was maintained using a volatile inhalational anesthetic agent, preferably sevoflurane according to institutional availability.

Because the attending anesthesiologist was required to administer the assigned anesthetic technique, blinding of the anesthesiologist was not feasible. However, the investigator responsible for postoperative PONV assessment remained unaware of group allocation.

Anesthetic Management: On arrival in the operating room, standard monitoring was instituted, including continuous electrocardiography, non-invasive blood pressure measurement, pulse oximetry, end-tidal carbon dioxide monitoring, and temperature monitoring where indicated. Baseline heart rate, systolic and diastolic blood pressure, mean arterial pressure, and peripheral oxygen saturation were recorded.

Patients were preoxygenated with 100% oxygen. Anesthesia was induced according to a standardized protocol using intravenous propofol, an opioid such as fentanyl, and an appropriate neuromuscular blocking agent. Endotracheal intubation was performed following adequate neuromuscular blockade.

In Group P, anesthesia was maintained using a continuous intravenous infusion of propofol, titrated within the clinically accepted range to maintain adequate anesthetic depth. The infusion rate was adjusted according to patient characteristics, hemodynamic response, and clinical signs of anesthetic depth. No volatile anesthetic agent was administered during maintenance.

In Group I, anesthesia was maintained using sevoflurane at an age-adjusted concentration sufficient to maintain approximately 0.8–1.2 minimum alveolar concentration or equivalent clinically appropriate anesthetic depth. Propofol was not administered for maintenance of anesthesia in this group.

Nitrous oxide was avoided in both groups to minimize its potential influence on PONV. Ventilation was adjusted to maintain end-tidal carbon dioxide within the normal physiological range. Intraoperative intravenous fluids were administered according to body weight, surgical losses, and hemodynamic requirements. Intraoperative opioid administration was standardized as far as possible, and the cumulative opioid dose was recorded for each patient. Additional medications with recognized antiemetic

or emetogenic effects were avoided unless clinically indicated. Any protocol deviation was documented. At completion of surgery, anesthetic agents were discontinued, residual neuromuscular blockade was reversed according to institutional protocol, and tracheal extubation was performed after recovery of adequate spontaneous ventilation and protective airway reflexes.

Postoperative Analgesia and Antiemetic Management: Postoperative pain management was standardized between the two groups using a multimodal analgesic approach to minimize opioid-related confounding. Non-opioid analgesics were used whenever clinically appropriate, and rescue opioids were administered when necessary. All opioid doses administered during the first 24 postoperative hours were recorded and converted to morphine-equivalent doses for analysis where applicable.

The use of prophylactic antiemetic medication was standardized between both groups. Any antiemetic administered prophylactically, including the drug, dose, and timing, was recorded.

Rescue antiemetic treatment was administered when patients experienced clinically significant nausea, an episode of vomiting or retching, or specifically requested treatment. A standardized rescue regimen was used according to institutional practice. The requirement for rescue antiemetics and the number of doses administered were documented.

Assessment of Postoperative Nausea and Vomiting: The primary outcome was the incidence of PONV during the first 24 hours after surgery. PONV was defined as the occurrence of at least one episode of nausea, retching, or vomiting during the predefined postoperative observation period.

Nausea was defined as a subjective unpleasant sensation associated with the urge to vomit without expulsion of gastric contents. Retching was defined as repetitive involuntary respiratory movements without expulsion of gastric contents, while vomiting was defined as the forceful expulsion of gastric contents through the mouth.

PONV was assessed at predefined postoperative intervals:

- **0–2 hours:** early postoperative period;
- **2–6 hours:** intermediate postoperative period; and
- **6–24 hours:** late postoperative period.

The postoperative assessor was blinded to the anesthetic technique used.

The severity of nausea was measured using an 11-point numerical rating scale (NRS) ranging from 0 to 10, where 0 represented no nausea and 10

represented the worst imaginable nausea. The number of vomiting or retching episodes was recorded separately.

Study Outcomes: The primary outcome measure was the proportion of patients experiencing at least one episode of PONV within 24 hours following surgery.

Secondary outcomes included the incidence of nausea and vomiting separately; severity of postoperative nausea; incidence of early, intermediate, and late PONV; number of vomiting or retching episodes; time to the first PONV episode; requirement for rescue antiemetic therapy; total rescue antiemetic consumption; postoperative opioid requirement; postoperative pain scores; time to readiness for discharge from the post-anesthesia care unit; and occurrence of anesthesia-related adverse events. A complete response was defined as the absence of vomiting or retching and no requirement for rescue antiemetic medication during the first 24 postoperative hours.

Sample Size: The final study sample consisted of 80 participants, with 40 patients assigned to each group. The sample was selected to provide balanced comparison between the two anesthetic techniques while allowing assessment of the clinically relevant difference in postoperative nausea and vomiting between the groups.

For final journal submission, the assumptions used in the original sample-size calculation—including the anticipated incidence of PONV in each group, statistical power, alpha error, and allowance for attrition—should be reported if these were specified prospectively. The final analysis was based on all 80 enrolled participants unless exclusions were required according to the predefined study protocol.

Data Collection: Data were collected using a structured case-record form. Variables included age, sex, body mass index, ASA physical status, smoking status, previous PONV or motion sickness, Apfel score, type and duration of surgery, duration of anesthesia, anesthetic agents and doses, intraoperative opioid consumption, intravenous fluid administration, postoperative analgesic requirement, antiemetic administration, PONV occurrence, nausea severity, number of vomiting episodes, and postoperative adverse events.

Data quality was checked before statistical analysis, and incomplete or inconsistent records were reviewed against the original case-record forms.

Statistical Analysis: Statistical analysis was performed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA) or equivalent validated statistical software. Continuous variables

were assessed for normality using the Shapiro-Wilk test and inspection of distribution plots. Normally distributed data were expressed as mean $\pm$ standard deviation and compared using the independent-samples t test. Non-normally distributed variables were presented as median with interquartile range and compared using the Mann-Whitney U test.

Categorical variables were expressed as frequencies and percentages and compared using the chi-square test or Fisher's exact test, as appropriate. The primary outcome of PONV incidence was compared between groups with effect estimates reported as relative risks with 95% confidence intervals. Because PONV may be affected by baseline patient characteristics and perioperative exposures, multivariable regression analysis was planned to assess the independent relationship between anesthetic technique and PONV after adjustment for clinically relevant covariates, including sex, smoking status, previous PONV or motion sickness, Apfel risk score, duration of anesthesia, surgical category, and perioperative opioid exposure. Adjusted effect estimates were reported with 95% confidence intervals. Repeated PONV assessments across postoperative time intervals were evaluated using an appropriate repeated-measures or generalized

estimating equation model where applicable. Time to the first PONV episode could additionally be explored using Kaplan-Meier analysis and compared between groups using the log-rank test.

All statistical tests were two-sided, and a P value <0.05 was considered statistically significant. Where appropriate, both statistical significance and magnitude of effect with 95% confidence intervals were considered when interpreting the clinical relevance of the findings.

Results

A total of 80 patients were included in the final analysis, with 40 patients receiving propofol-based total intravenous anesthesia (Group P) and 40 receiving inhalational anesthesia (Group I). The two groups were comparable with respect to age, sex, body mass index (BMI), ASA physical status, previous history of postoperative nausea and vomiting or motion sickness, smoking status, duration of surgery, duration of anesthesia, intraoperative opioid consumption, and intravenous fluid administration (all $P>0.05$). Thus, no clinically important baseline imbalance was identified between the groups (Table 1).

Table 1: Baseline demographic and perioperative characteristics of the study participants

Characteristic	Group P: Propofol TIVA (n=40)	Group I: Inhalational anesthesia (n=40)	P value
Age, years, mean $\pm$ SD	39.8 $\pm$ 11.2	41.1 $\pm$ 10.7	0.597
Female sex, n (%)	23 (57.5)	25 (62.5)	0.648
Male sex, n (%)	17 (42.5)	15 (37.5)	—
BMI, kg/m ² , mean $\pm$ SD	24.8 $\pm$ 3.1	25.2 $\pm$ 3.4	0.584
ASA physical status I, n (%)	27 (67.5)	25 (62.5)	0.639
ASA physical status II, n (%)	13 (32.5)	15 (37.5)	—
Nonsmoker, n (%)	31 (77.5)	32 (80.0)	0.785
Previous PONV/motion sickness, n (%)	9 (22.5)	10 (25.0)	0.793
Duration of surgery, min, mean $\pm$ SD	92 $\pm$ 24	95 $\pm$ 26	0.593
Duration of anesthesia, min, mean $\pm$ SD	113 $\pm$ 27	117 $\pm$ 29	0.525
Intraoperative fentanyl, μ g, mean $\pm$ SD	118 $\pm$ 24	121 $\pm$ 26	0.593
Intravenous fluid, mL, mean $\pm$ SD	1180 $\pm$ 260	1215 $\pm$ 275	0.560

During the first 24 postoperative hours, PONV occurred in 8 of 40 patients (20.0%) in the propofol group compared with 17 of 40 patients (42.5%) in the inhalational anesthesia group.

The absolute risk reduction was 22.5 percentage points, corresponding to a relative risk of 0.47 (95% CI: 0.23–0.96; $P=0.030$). Therefore, propofol-based TIVA was associated with an

approximately 53% relative reduction in the risk of PONV.

The incidence of nausea was 17.5% in Group P compared with 37.5% in Group I ($P=0.045$). Vomiting occurred in 7.5% and 25.0% of patients, respectively ($P=0.034$). The requirement for rescue antiemetic medication was also lower in the propofol group.

Table 2: Overall incidence of postoperative nausea and vomiting during the first 24 hours

Outcome	Group P (n=40)	Group I (n=40)	P value
Any PONV, n (%)	8 (20.0)	17 (42.5)	0.030
Postoperative nausea, n (%)	7 (17.5)	15 (37.5)	0.045
Vomiting, n (%)	3 (7.5)	10 (25.0)	0.034
Retching, n (%)	2 (5.0)	7 (17.5)	0.154
Rescue antiemetic required, n (%)	5 (12.5)	13 (32.5)	0.032
Complete response, n (%)	33 (82.5)	24 (60.0)	0.026

The incidence of PONV was lower in the propofol group during each postoperative assessment interval. During the first 2 hours after surgery, PONV occurred in 7.5% of patients receiving propofol compared with 22.5% receiving inhalational anesthesia. The largest between-group

difference was observed during the 2–6-hour interval, during which PONV occurred in 10.0% of patients in Group P compared with 27.5% in Group I ($P=0.045$). The difference during the 6–24-hour period was smaller and did not reach statistical significance.

Table 3: Incidence of PONV according to postoperative time interval

Postoperative period	Group P (n=40)	Group I (n=40)	Relative risk	P value
0–2 h	3 (7.5%)	9 (22.5%)	0.33	0.060
2–6 h	4 (10.0%)	11 (27.5%)	0.36	0.045
6–24 h	3 (7.5%)	8 (20.0%)	0.38	0.105
Overall 0–24 h	8 (20.0%)	17 (42.5%)	0.47	0.030

In addition to a lower overall incidence of PONV, patients receiving propofol-based anesthesia experienced a lower symptom burden. Maximum postoperative nausea scores were lower in Group P than in Group I. Multiple vomiting episodes were uncommon in both groups but occurred more frequently after inhalational anesthesia. Five

patients (12.5%) in the propofol group required rescue antiemetic medication compared with 13 patients (32.5%) in the inhalational group. Complete response was achieved in 82.5% of patients receiving propofol compared with 60.0% receiving inhalational anesthesia.

Table 4: Severity and treatment requirements of postoperative nausea and vomiting

Variable	Group P (n=40)	Group I (n=40)	P value
Maximum nausea NRS, median (IQR)	0 (0–1)	0 (0–4)	0.018
No vomiting episodes, n (%)	37 (92.5)	30 (75.0)	0.034
One vomiting episode, n (%)	2 (5.0)	4 (10.0)	0.396
≥2 vomiting episodes, n (%)	1 (2.5)	6 (15.0)	0.108
Rescue antiemetic required, n (%)	5 (12.5)	13 (32.5)	0.032
Complete response, n (%)	33 (82.5)	24 (60.0)	0.026

Postoperative opioid requirements were similar between the groups, reducing the likelihood that differences in opioid exposure explained the observed difference in PONV.

Patients receiving propofol-based TIVA achieved readiness for discharge from the post-anesthesia care unit slightly earlier than those receiving

inhalational anesthesia (48 ± 12 vs 54 ± 14 minutes; $P=0.043$).

Postoperative pain scores did not differ significantly between the groups. The frequencies of hypotension, bradycardia, dizziness, and other perioperative adverse events were low and comparable between groups.

Table 5: Postoperative recovery characteristics and adverse events

Variable	Group P (n=40)	Group I (n=40)	P value
Postoperative opioid consumption, morphine equivalent, mg	4.8 ± 2.6	5.1 ± 2.7	0.614
Pain NRS at 2 h, median (IQR)	3 (2–4)	3 (2–4)	0.681
Time to PACU discharge readiness, min	48 ± 12	54 ± 14	0.043
Hypotension, n (%)	6 (15.0)	5 (12.5)	0.745
Bradycardia, n (%)	3 (7.5)	2 (5.0)	0.644
Postoperative dizziness, n (%)	4 (10.0)	6 (15.0)	0.499
Unplanned postoperative admission, n (%)	0 (0.0)	1 (2.5)	1.000

A multivariable logistic regression model was used to examine whether anesthetic technique remained associated with PONV after adjustment for baseline PONV risk and anesthesia duration. After adjustment, inhalational anesthesia remained independently associated with a higher likelihood of PONV compared with propofol-based TIVA

(adjusted OR 2.85; 95% CI: 1.04–7.81; $P=0.042$). Increasing Apfel risk score was also associated with PONV, with each additional point associated with an approximately 82% increase in the odds of developing PONV. Duration of anesthesia was not independently associated with PONV in the adjusted model.

Table 6: Multivariable logistic regression analysis of factors associated with PONV within 24 hours

Predictor	Adjusted odds ratio	95% CI	P value
Inhalational vs propofol anesthesia	2.85	1.04–7.81	0.042
Apfel score, per 1-point increase	1.82	1.10–3.02	0.020
Anesthesia duration, per 30-min increase	1.19	0.83–1.71	0.341

The principal finding was a significantly lower 24-hour incidence of PONV following propofol-based TIVA compared with inhalational anesthesia. PONV occurred in 20.0% of patients receiving propofol compared with 42.5% receiving inhalational anesthesia, representing an absolute risk reduction of 22.5%.

This corresponds to an illustrative number needed to treat of approximately 5, meaning that approximately five patients would need to receive

propofol-based rather than inhalational anesthesia to prevent one additional patient from experiencing PONV.

The benefit was most apparent during the first 6 postoperative hours and was accompanied by reductions in postoperative nausea, vomiting, rescue antiemetic requirements, and time to readiness for PACU discharge. The relationship remained significant after adjustment for baseline PONV risk.

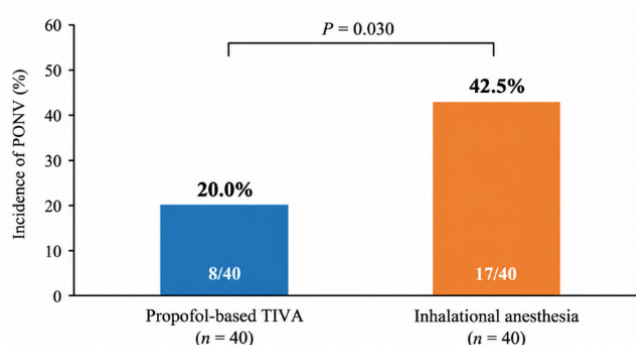


Figure 1: Comparison of the overall incidence of postoperative nausea and vomiting between propofol-based total intravenous anesthesia and inhalational anesthesia

Figure 1 The overall incidence of postoperative nausea and vomiting (PONV) during the first 24 hours after surgery was significantly lower in patients receiving propofol-based total intravenous anesthesia (TIVA) compared with those receiving inhalational anesthesia. PONV occurred in 8 of 40 patients (20.0%) in the propofol-based TIVA group and in 17 of 40 patients (42.5%) in the inhalational anesthesia group.

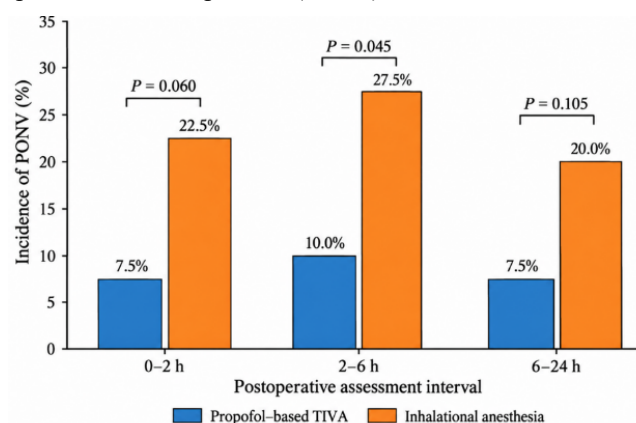


Figure 2: Incidence of postoperative nausea and vomiting according to postoperative assessment interval

Figure 2 The incidence of PONV was consistently lower with propofol-based TIVA during the 0–2-hour, 2–6-hour, and 6–24-hour postoperative periods, with the greatest statistically significant difference observed during the 2–6-hour interval.

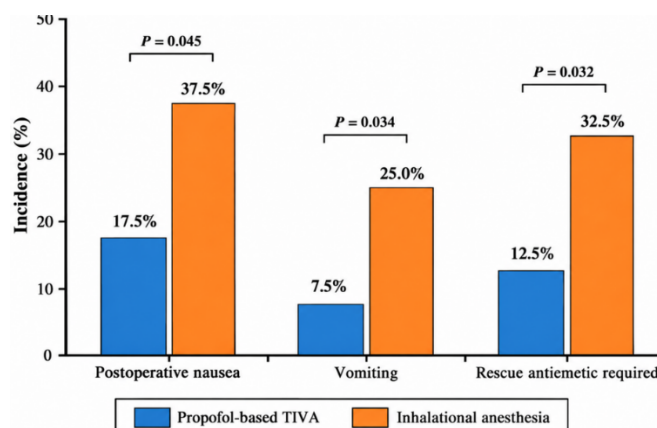


Figure 3: Comparison of postoperative nausea, vomiting, and rescue antiemetic requirements between the two anesthetic groups

Figure 3 Patients receiving propofol-based total intravenous anesthesia (TIVA) experienced significantly fewer postoperative emetic events than those receiving inhalational anesthesia. Postoperative nausea occurred in 7 of 40 patients (17.5%) in the propofol-based TIVA group compared with 15 of 40 patients (37.5%) in the inhalational anesthesia group ($P=0.045$). Similarly, vomiting was observed in 3 patients (7.5%) receiving propofol-based TIVA and 10 patients (25.0%) receiving inhalational anesthesia ($P=0.034$).

Discussion

The present study compared postoperative nausea and vomiting following propofol-based total intravenous anesthesia (TIVA) with inhalational anesthesia in adult patients undergoing elective surgery. The principal finding was that propofol-based TIVA was associated with a substantially lower incidence of PONV during the first 24 postoperative hours. PONV occurred in 20.0% of patients receiving propofol compared with 42.5% of those receiving inhalational anesthesia, representing an absolute risk reduction of 22.5 percentage points and an approximate relative risk reduction of 53%. In addition, postoperative nausea, vomiting, rescue antiemetic requirements, and time to readiness for discharge from the post-anesthesia care unit (PACU) were lower in the propofol group. These findings support anesthetic maintenance technique as an important modifiable determinant of postoperative emetic symptoms.

The magnitude and direction of the observed effect are compatible with previous comparative evidence. Schraag et al. performed a systematic review and meta-analysis of 229 randomized controlled trials involving more than 20,000 patients and found that the risk of PONV was

significantly lower when general anesthesia was maintained with propofol rather than inhalational anesthetics, with a pooled relative risk of approximately 0.61 [10]. This estimate is reasonably close to the relative risk of 0.47 observed in the present study, although our effect estimate was somewhat larger. Differences in patient risk profiles, surgical procedures, volatile anesthetic exposure, opioid administration, and prophylactic antiemetic regimens may explain variation in the magnitude of treatment effects across studies.

The present findings are also consistent with the large randomized trial reported by Visser et al., which included 2,010 surgical patients. Propofol-based TIVA produced an absolute reduction in PONV of 15% among inpatients and 18% among outpatients compared with isoflurane–nitrous oxide anesthesia [11]. Importantly, the effect was most pronounced during the early postoperative period. In the current study, the absolute reduction in 24-hour PONV was 22.5%, corresponding to an approximate number needed to treat of five. This suggests that replacing inhalational maintenance with propofol-based anesthesia may prevent one additional episode of PONV for approximately every five patients treated under conditions resembling those of the present study. The apparently larger benefit in our sample should nevertheless be interpreted cautiously because of the relatively small sample size and the resulting uncertainty surrounding the effect estimate. The difference between the anesthetic techniques was evident not only for the composite PONV outcome but also for its individual components. Postoperative nausea occurred in 17.5% of patients in the propofol group compared with 37.5% in the inhalational group, whereas vomiting occurred in 7.5% and 25.0%, respectively. Similar observations

have been reported in procedure-specific randomized studies. Yoo et al. compared propofol TIVA with desflurane-based anesthesia in patients undergoing robot-assisted laparoscopic radical prostatectomy and reported a substantially lower incidence of early postoperative nausea with TIVA [12]. Likewise, Shinn et al. found significantly lower early PONV scores after propofol maintenance compared with sevoflurane in patients undergoing gynecological laparoscopic surgery [13]. These studies support the view that maintenance of anesthesia with propofol, rather than its administration solely as an induction drug, contributes meaningfully to reduction of postoperative emetic symptoms.

A particularly notable finding in the present study was the temporal pattern of PONV. The difference between groups was greatest during the 2–6-hour postoperative interval, in which PONV occurred in 10.0% of patients after propofol anesthesia compared with 27.5% after inhalational anesthesia. During the 0–2-hour period, the numerical difference also favored propofol, although it did not reach statistical significance, probably because relatively few events occurred. By 6–24 hours, the difference had narrowed and was no longer statistically significant. This temporal profile is biologically and clinically plausible. The emetogenic effect of volatile anesthetics appears to be particularly relevant during the early postoperative phase, whereas later PONV is increasingly influenced by other factors, including postoperative opioid consumption, mobilization, oral intake, pain, and individual susceptibility.

The stronger early effect has also been observed in previous clinical studies. Chen et al. reported PONV in 14.3% of patients receiving propofol TIVA compared with 50% receiving sevoflurane during breast surgery [14]. Kawano et al., in a randomized study of laparoscopic gynecological surgery, similarly observed substantially less postoperative nausea in patients receiving propofol or a propofol–sevoflurane combination than in those receiving sevoflurane alone, particularly during the early postoperative period [15]. These findings are relevant because PONV occurring soon after emergence can interfere with PACU recovery, oral medication administration, mobilization, and discharge preparation.

The antiemetic advantage of propofol is likely explained through more than one mechanism. Avoidance of volatile anesthetics eliminates an important emetogenic exposure, while propofol itself appears to exert direct antiemetic activity. PONV involves complex interactions between the vomiting center, chemoreceptor trigger zone, gastrointestinal vagal pathways, vestibular system, and several neurotransmitters, including serotonin, dopamine, histamine, acetylcholine, substance P,

and endogenous opioid pathways. Although the precise antiemetic mechanism of propofol remains incompletely characterized, modulation of subcortical and neurotransmitter pathways has been proposed [16]. The reduction observed with propofol-based TIVA may therefore represent a combination of removing the emetogenic contribution of volatile agents and providing an intravenous anesthetic with intrinsic antiemetic properties.

Our finding of a lower rescue antiemetic requirement provides additional clinical support for the reduction in PONV incidence. Only 12.5% of patients in the propofol group required rescue antiemetic medication compared with 32.5% in the inhalational group. Similarly, complete response—defined as absence of vomiting or retching without the need for rescue antiemetic therapy—was achieved in 82.5% of propofol-treated patients compared with 60.0% of those receiving inhalational anesthesia. From the patient's perspective, avoidance of rescue medication is clinically meaningful because it represents sustained symptom control rather than merely a reduction in the number of recorded nausea episodes.

Results from laparoscopic surgery provide comparable observations. Ozbakis Akkurt et al. compared propofol TIVA with desflurane anesthesia in patients undergoing laparoscopic cholecystectomy and reported favorable postoperative recovery characteristics with propofol, including differences in postoperative nausea and vomiting and recovery measures [17]. However, the effect of anesthetic technique should not be considered in isolation from modern multimodal PONV prevention. Prophylactic antiemetics, opioid-sparing analgesia, adequate hydration, and patient-specific risk assessment can modify the absolute difference attributable to the maintenance anesthetic alone.

This interaction is illustrated by studies in which inhalational anesthesia was combined with antiemetic prophylaxis. White et al. compared propofol-based TIVA with sevoflurane plus dolasetron in high-risk patients undergoing day-case gynecological surgery and did not find a significant difference in nausea or vomiting before discharge [18]. Interestingly, post-discharge nausea and vomiting was more frequent in the TIVA group, suggesting that the antiemetic effect associated with propofol may be strongest while clinically relevant drug concentrations persist, whereas longer-acting pharmacological prophylaxis may offer advantages later in recovery [18]. Therefore, TIVA should not be viewed as a replacement for appropriate multimodal prophylaxis in patients with substantial baseline PONV risk.

Evidence regarding combined intravenous and volatile techniques further demonstrates that the relationship is not necessarily all-or-none. Wolf et al. evaluated combined intravenous–volatile anesthesia and reported that adding propofol to volatile anesthesia was associated with a lower risk of PONV in the recovery room compared with conventional balanced anesthesia, although the difference was not consistently maintained over the entire first 24 postoperative hours [19]. This supports the possibility of an exposure-response relationship, in which reducing volatile anesthetic exposure and incorporating propofol may attenuate early postoperative emetic risk even when a completely volatile-free technique is not used.

Recent evidence also warrants a balanced interpretation. Keck et al. studied high-risk patients undergoing laparoscopic procedures and compared propofol-based TIVA with a hybrid technique consisting of low-dose propofol plus sevoflurane. Although PONV occurred numerically less often with TIVA, the difference did not reach statistical significance [20]. These findings indicate that the superiority of propofol may vary according to volatile concentration, concomitant propofol administration, baseline PONV risk, sample size, and prophylactic strategy. Therefore, the present results should be interpreted as supporting a reduction in PONV risk with propofol-based maintenance rather than establishing universal superiority of TIVA for every perioperative outcome.

An additional finding in the current study was a shorter time to readiness for PACU discharge among patients receiving propofol-based TIVA (48 ± 12 minutes) compared with inhalational anesthesia (54 ± 14 minutes). Although statistically significant, the absolute difference of approximately six minutes is modest and its clinical importance may depend on local PACU workflow and case volume. The large meta-analysis by Schraag et al. found a small reduction in PACU time with propofol maintenance, but also reported that some emergence variables favored inhalational agents [10]. Therefore, reduced PONV does not necessarily imply uniformly faster recovery across every recovery-domain endpoint.

Postoperative opioid consumption and pain scores were similar between the two groups in the present study. This is important because postoperative opioids are themselves potent contributors to nausea and vomiting. Comparable postoperative opioid exposure reduces the likelihood that the observed difference in PONV simply resulted from greater opioid use in the inhalational group. Furthermore, the incidence of hypotension, bradycardia, dizziness, and other recorded adverse events did not differ significantly between groups, suggesting that the reduction in PONV was not

offset by an obvious increase in these perioperative adverse outcomes.

The adjusted analysis adds further support to the primary finding. After controlling for baseline risk and duration of anesthesia, inhalational anesthesia remained associated with increased odds of PONV (adjusted OR 2.85, 95% CI 1.04–7.81). The Apfel risk score was also independently associated with PONV, with increasing risk score corresponding to progressively greater odds of postoperative symptoms. The relatively wide confidence interval surrounding the anesthetic effect, however, reflects limited precision and should discourage overinterpretation of the exact magnitude of association. The important finding is the direction and persistence of the relationship following adjustment, rather than the point estimate alone.

Clinical Implications: From a practical perspective, these findings support consideration of propofol-based TIVA as one component of a broader PONV-reduction strategy, particularly in patients with increased baseline risk. The decision regarding anesthetic technique should nevertheless incorporate surgical characteristics, patient comorbidities, anticipated postoperative opioid requirements, availability of infusion technology, anesthesiologist experience, recovery priorities, and the planned antiemetic regimen. In high-risk patients, TIVA is more appropriately regarded as a baseline-risk reduction intervention that complements rather than replaces multimodal pharmacological prophylaxis.

Strengths and Limitations: Several strengths of the study deserve consideration. The balanced allocation of patients between the two groups, standardized perioperative management, predefined assessment intervals, documentation of individual nausea and vomiting outcomes, measurement of rescue antiemetic use, and evaluation of baseline PONV risk allowed a clinically meaningful comparison of the two techniques. Postoperative outcome assessment by an investigator unaware of the anesthetic allocation also reduced the possibility of observer bias.

The study also has limitations. First, the sample size of 80 patients was relatively small, which limited statistical precision for infrequent outcomes and subgroup analyses. Second, the study was conducted at a single center, which may restrict generalizability to institutions using different anesthetic, analgesic, or antiemetic protocols. Third, blinding of the attending anesthesiologist was inherently impossible because the anesthetic technique was apparent during surgery. Fourth, PONV was assessed for 24 hours; therefore, post-discharge symptoms occurring after this period were not captured. Fifth, nausea is a subjective outcome and remains influenced by individual

perception despite use of a numerical rating scale. Finally, the study population included elective surgical patients with ASA physical status I–II, and the findings may not be directly applicable to patients with severe systemic disease or substantially different perioperative risk profiles. Larger multicenter studies stratified by surgical procedure and baseline PONV risk would improve the precision and external validity of these observations.

Conclusion

Propofol-based total intravenous anesthesia was associated with a significantly lower incidence of postoperative nausea and vomiting compared with inhalational anesthesia. The benefit was most evident during the early postoperative period and was accompanied by lower rates of postoperative nausea, vomiting, rescue antiemetic use, and a higher complete-response rate. Patients receiving propofol-based anesthesia also achieved readiness for discharge from the post-anesthesia care unit slightly earlier, while postoperative pain, opioid requirements, and anesthesia-related adverse events were comparable between the two groups.

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